# GENERATIONS TO EXTINCTION

*A manifesto about replacement, compounding, and the quiet violence of exponential decline*

**Xema Gatnau**

August 2026

This is a scenario, not a prophecy. If fertility remains below replacement for long enough, the arithmetic of compounding eventually dominates. The central claim is not that extinction is imminent, but that persistent below-replacement fertility is a trajectory, not a static condition.

**Replacement is a threshold. Decline is a process. Extinction is the limiting case of that process.**

## Abstract

This manifesto isolates one demographic mechanism: repeated multiplication across generations. Using a deliberately simplified discrete-generation model, it shows how a total fertility rate below replacement translates into an exponential decline in population when sustained. The document expands the basic model with demographic half-life, threshold analysis, a calendar-time translation, a distinction between global extinction and subpopulation disappearance, and a migration identity that separates global arithmetic from local population replacement. It also adds an important technical refinement: for empirical demographic work, the net reproduction rate is a more direct measure of generational replacement than the simplified multiplier F/2. Finally, it examines the point at which prolonged, understood and uncorrected demographic decline can be described, with due caution, as voluntary extinction, and extends that intuition toward the idea of multicivilizational suicide: the simultaneous convergence of societies belonging to different civilizational traditions toward fertility regimes below replacement. The text also advances a hypothesis that requires caution: economic and social modernization appears to generate a recurrent pressure toward sub-replacement fertility, without this amounting to an inexorable law. Its purpose is not prediction, but disciplined long-run thinking.

**Keywords: fertility; replacement; demographic decline; exponential compounding; extinction; voluntary extinction; multicivilizational suicide; demographic transition; modernization; subpopulation replacement; net reproduction rate; demographic resilience**

## 1. The thesis in six propositions

- Below replacement, population decline compounds. A society does not lose the same number of people each generation; it repeatedly multiplies a smaller base.
- Small differences in fertility become very large differences over long horizons. The arithmetic is nonlinear in time even when the multiplier is constant.
- The disappearance of a population and the extinction of humanity are different questions. One group can contract toward disappearance while another remains stable or expands.
- Migration can redistribute population between places and groups, but at the global level it cannot create people. It changes composition; it does not change the global accounting identity.
- Variation in fertility norms can therefore act as demographic redundancy. If all groups converge permanently below replacement, the global system loses that redundancy.
- If several societies belonging to different civilizational traditions understand a persistent below-replacement trajectory, possess meaningful freedom and capacity to alter it, and nevertheless converge over generations toward the same outcome, the phenomenon can be described metaphorically as a form of multicivilizational suicide: not a coordinated decision, but an independent convergence toward insufficient reproduction.

The manifesto asks for one intellectual discipline above all: when discussing demographic futures, count in generations rather than in election cycles.

## 2. The general model

Let $t = 0, 1, 2, \ldots$ denote generations. Let $P_0$ be the initial population and F the total fertility rate (children per woman) in the scenario. In the simplest two-sex, discrete-generation approximation, replacement is represented by $F \approx 2$, so the population multiplier per generation is:

$$g \approx F / 2$$

Population after t generations is therefore:

$$P(t) = P_0 \cdot g^t = P_0 \cdot (F/2)^t$$

For any threshold P*, the number of generations needed to fall below it is:

$$t = \ln(P^*/P_0) / \ln(g)$$

When $F < 2$, then $g < 1$ and $\ln(g)$ is negative. The decline is exponential. On a logarithmic population axis, constant-rate exponential decline appears as a straight line.

Assumptions of the thought experiment: constant fertility, closed global system, discrete generations, balanced two-sex approximation, and no explicit age structure or mortality schedule. These assumptions make the mechanism visible; they do not make the model a forecast.

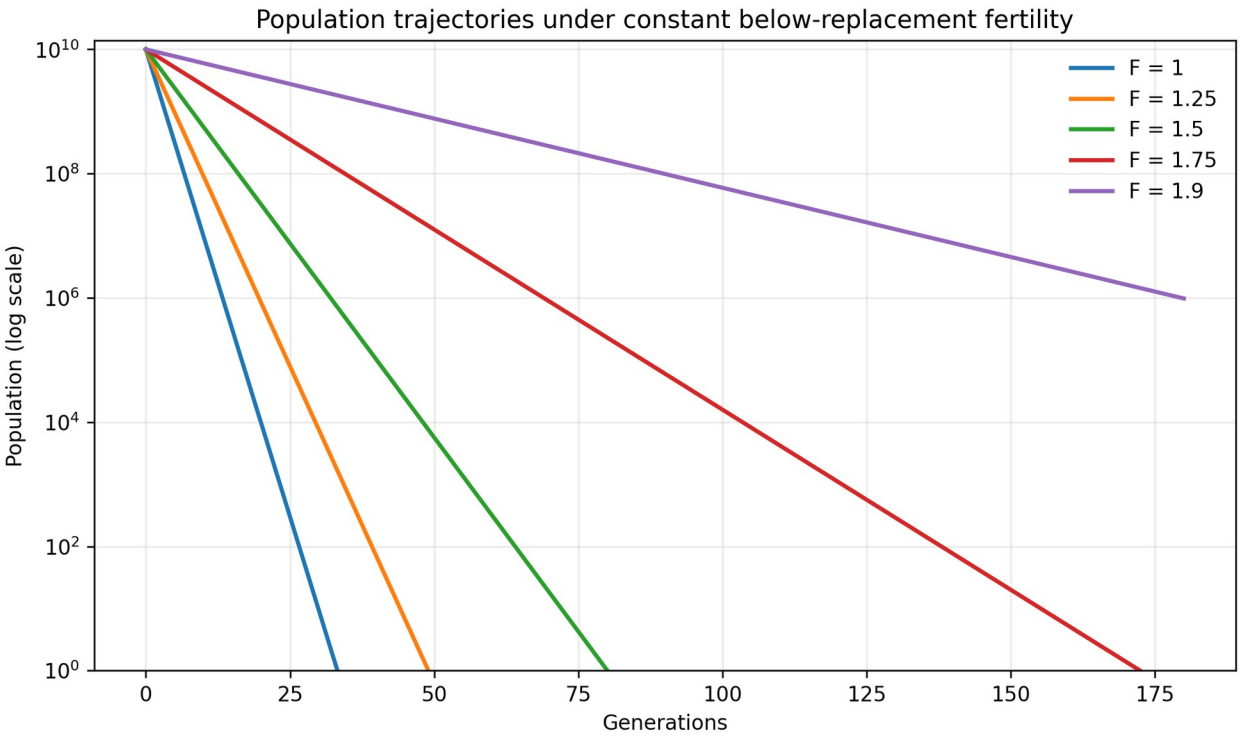


*Figure 1. Population trajectories from an illustrative initial population of 10 billion under constant below-replacement fertility. The vertical axis is logarithmic.*

## 3. Demographic half-life: a more intuitive metric

A useful addition to the original threshold calculation is the demographic half-life: the number of generations required for a population to fall to half its size if the multiplier remains constant.

$$t_{½} = \ln(0.5) / \ln(g)$$

This makes the compounding mechanism easier to grasp. At F = 1.50, g = 0.75 and the population halves roughly every 2.4 generations. At F = 1.75, it halves roughly every 5.2 generations. At F = 1.90, the decline looks slow in the short run, but the half-life is still finite: about 13.5 generations.

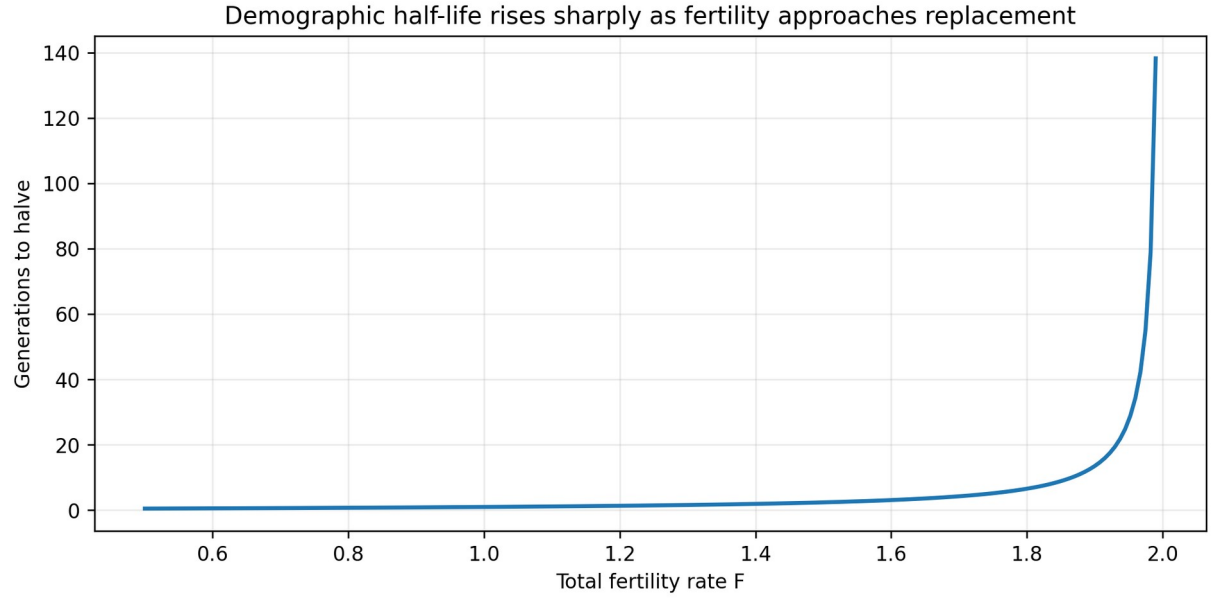
Demographic half-life rises sharply as fertility approaches replacement
Generations to halve
Total fertility rate F

*Figure 2. As fertility approaches replacement from below, the half-life becomes longer, but does not become infinite until the multiplier reaches one.*

## 4. Thresholds from an initial population of 10 billion

The original manifesto used three fertility scenarios. The table below preserves those values and extends the sensitivity range. Values are approximate generations required to cross each threshold.

| F (TFR) | g = F/2 | Half-life | to 1B | to 100M | to 1M | to P < 4 | to P < 1 |
|---|---|---|---|---|---|---|---|
| 1.90 | 0.950 | 13.5 | 44.9 | 89.8 | 179.6 | 421.9 | 448.9 |
| 1.75 | 0.875 | 5.2 | 17.2 | 34.5 | 69.0 | 162.1 | 172.4 |
| 1.50 | 0.750 | 2.4 | 8.0 | 16.0 | 32.0 | 75.2 | 80.0 |
| 1.25 | 0.625 | 1.5 | 4.9 | 9.8 | 19.6 | 46.0 | 49.0 |
| 1.00 | 0.500 | 1.0 | 3.3 | 6.6 | 13.3 | 31.2 | 33.2 |
| 0.75 | 0.375 | 0.7 | 2.3 | 4.7 | 9.4 | 22.1 | 23.5 |
| 0.50 | 0.250 | 0.5 | 1.7 | 3.3 | 6.6 | 15.6 | 16.6 |

**Why include P < 4?** Because P < 1 is only a mathematical endpoint. Long before a population reaches a single individual, ordinary reproduction ceases to be a stable population process. The exact viability threshold is not specified here; P < 4 remains a deliberately symbolic warning threshold.

## 5. From generations to calendar time

Generations are the clean unit for the model, but readers often think in years. If L denotes average generation length, then an approximate calendar horizon is simply:

$$\text{Years} \approx t \cdot L$$

For illustration only, with L = 30 years:

- F = 1.75: falling from 10 billion to 1 billion takes about 17.2 generations, or roughly 516 years; the mathematical P < 1 threshold lies more than five millennia away.
- F = 1.50: the 1-billion threshold arrives in about 8 generations, or roughly 240 years; P < 1 is about 2,400 years.
- F = 1.25: the 1-billion threshold arrives in about 4.9 generations, or roughly 147 years; P < 1 is about 1,470 years.

> The lesson is not that extinction is “soon.” It is that persistent sub-replacement fertility has a mathematically defined direction, and the earlier thresholds can arrive centuries before the endpoint.

## 6. A technical refinement: TFR is not itself the replacement multiplier

The expression $g \approx F/2$ is intentionally pedagogical. In empirical demography, a more direct generational replacement measure is the net reproduction rate (NRR): the expected number of daughters born to a woman over her lifetime under the prevailing fertility and mortality schedule. In that framework, NRR = 1 corresponds to exact generational replacement.

Why this matters: total fertility rate summarizes period fertility, while actual generational replacement also depends on survival to reproductive ages, sex composition, timing, and cohort structure. For a serious empirical application, the cleanest extension of this manifesto is therefore to replace the simplified g with an empirically estimated reproduction multiplier.

$$P(t) \approx P_0 \cdot R^t \quad \text{where R is an empirical generational reproduction multiplier}$$

> The simplified model remains valuable because the qualitative result survives the refinement: if the long-run effective reproduction multiplier stays below one, compounding drives the population downward.

## 7. Global extinction and subpopulation disappearance are not the same

The world is not one homogeneous reproductive system. Different populations can have different fertility, mortality, migration, assimilation, and identity-transmission patterns. A global population can remain stable or even grow while particular subpopulations contract sharply.

For a subpopulation i, a minimal accounting identity is:

$$P_i(t+1) = g_i \cdot P_i(t) + M_i(t)$$

where $g_i$ captures internal generational reproduction and $M_i(t)$ is net migration into that population or territory over the period. At the global level, migration is a redistribution: when all territorial flows are summed, net migration is zero. Thus migration can alter local trajectories and composition, but it cannot solve a global reproduction deficit.

This distinction produces two separate long-run questions:

- Species continuity: does humanity as a whole maintain an effective reproduction multiplier at or above one over the long run?
- Population or cultural continuity: does a particular historical population reproduce itself biologically, culturally, or through some combination of descent, assimilation, and incorporation?

## 8. Pluralism as demographic resilience

The original manifesto makes a strong systems claim: variation can be a form of resilience. If some groups remain above or near replacement while others fall below it, the species as a whole does not follow the trajectory of the lowest-fertility group.

In systems language, heterogeneous fertility regimes provide redundancy. A civilization in which every population adopts the same permanently sub-replacement reproductive norm

removes that redundancy. Conversely, variation in family norms, social organization, and demographic behavior makes convergence toward one global demographic failure mode less likely.

> Diversity is usually discussed as a cultural value. Here it also appears as a systems property: non-uniformity can prevent one demographic equilibrium from becoming universal.

This idea acquires a more troubling dimension if modernization tends to homogenize reproductive behavior. Pluralism functions as redundancy only if cultural, institutional and family differences also produce different demographic trajectories. If historically very different societies converge toward the same low-fertility equilibrium, civilizational diversity ceases to protect the system against a common demographic failure mode.

## 9. What this model does not say

- It is not a forecast of a specific country or of the world population. Fertility changes, mortality changes, institutions react, and demographic behavior is endogenous.
- It does not claim that more population is always better. Ecological limits, welfare, productivity, and quality of life remain separate questions.
- It does not establish a coercive moral or political conclusion. The arithmetic identifies consequences; political legitimacy requires additional arguments.
- It does not identify a precise “minimum viable human population.” The handful-of-individuals threshold is symbolic, not an empirical biological claim.
- Calling a demographic trajectory “voluntary” does not mean that every individual intends the collective outcome. The term refers, at most, to an emergent social result under conditions of knowledge, freedom and persistence.

## 10. Why this still matters

Human intuition is poor at compounding. A fertility rate only modestly below replacement can look politically manageable for decades because the population stock changes slowly at first, especially when older and larger cohorts are still alive. But a stock can conceal a weakening flow. Once small cohorts become the parents of still smaller cohorts, the arithmetic becomes visible.

That is why the most important demographic variable is not merely today’s headcount. It is the ratio between successive generations and the persistence of that ratio. A large population with a reproduction multiplier below one is not demographically stationary; it is a large population moving along a declining path.

> A stock tells you where you are. A reproduction multiplier tells you where repeated time is taking you.

## 11. When decline becomes voluntary: extinction by choice and multicivilizational suicide

A civilization can disappear without being conquered, exterminated, or destroyed by a sudden catastrophe. If it maintains, generation after generation, an effective reproduction multiplier below one and does not reverse that trajectory despite understanding it and possessing meaningful capacity to respond, its disappearance can be described as a form of voluntary extinction.

The word voluntary requires precision. There need not be a referendum on disappearance, nor a conscious wish for collective death. The result can emerge from millions of individual decisions, incentives and institutions whose aggregate effect is that each generation fails to replace itself. This is a composition problem: no individual need intend extinction for the collective pattern to point toward it.

The stronger expression multicivilizational suicide is metaphorical, but it names a broader possibility than the suicide of a single civilization. The phenomenon appears when societies with very different histories, religions, languages, family structures and political systems converge, without coordinating with one another, toward persistently below-replacement reproduction. What is disturbing would not be a common decision to disappear, but the independent repetition of the same demographic outcome across several civilizational matrices.

There are clear empirical signs of this convergence, although not yet of global extinction. United Nations estimates indicate that more than half of the world's countries and areas are already below 2.1 children per woman and that close to one fifth have ultra-low fertility below 1.4. Global fertility, however, was still around 2.25 in the 2024 revision, so the concept of multicivilizational suicide here describes the simultaneity of decline across large historical regions, not a claim that humanity as a whole is already below replacement.

India is no longer a clear exception either. World Bank data place its total fertility rate at around 2.0 in 2024, approximately at - and slightly below, under the conventional 2.1 benchmark - replacement level. Its enormous demographic momentum and strong regional differences make its trajectory different from those of East Asia or Europe, but the national figure reinforces rather than weakens the hypothesis of a late convergence toward lower fertility.

This makes it possible to formulate a stronger hypothesis: economic modernization may be associated with a low-fertility demographic attractor. Industrialization, urbanization, higher education, delayed family formation, the rising opportunity cost of childrearing and changing family norms repeatedly appear alongside falling fertility. But it would be excessive to call this an inexorable law. Israel, with fertility around 2.8-2.9 and a high income level, is an important counterexample, and within many countries there are subpopulations with very different fertility patterns. The more rigorous formulation is therefore more modest, and perhaps more troubling: so far, the dominant tendency among developed societies has been to converge below replacement, and no general, stable recovery back to replacement has been observed.

- Sustained below-replacement reproduction over successive generations.
- Public knowledge, or at least reasonable awareness, of the long-run trajectory.
- Material and institutional capacity to alter the trajectory without coercive measures.

- Persistent failure or refusal to make changes sufficient to restore long-run replacement.

If decline is primarily caused by war, epidemics, forced sterilization, extreme deprivation, infertility, persecution or external domination, speaking of "voluntary extinction" would be misleading. Likewise, the trajectory is not destiny: if the effective reproduction multiplier returns to replacement before disappearance, the direction of compounding changes.

In this sense, the problem is no longer merely that one civilization may produce the conditions of its own disappearance. The multicivilizational risk appears when the same architecture of modernity reproduces similar pressures across independent civilizations. If that convergence were to consolidate, the demographic pluralism described in section 8 would lose part of its resilience function: there would no longer be several reproductive paths capable of offsetting one another, but several historical paths arriving at the same below-replacement equilibrium.

> Several civilizations do not need to coordinate their disappearance. It is enough that, by different paths, they converge one after another on the diffuse decision not to replace themselves.

## 12. Closing: count

People argue about culture, politics, morality, economics, migration, family, and freedom. Beneath all of them lies a quieter force: multiplication repeated across time.

Replacement is not a slogan. It is the boundary between a multiplier below one and a multiplier at one. Extinction is not a sudden event in this model. It is the limiting endpoint of a long sequence of smaller generations.

**The message is not “panic.” The message is “count.”**

*Below replacement, the future is not a slope - it is a staircase with a vanishing bottom. If you insist on thinking in the long run, learn to think in generations.*

## Methodological notes

- The initial population of 10 billion is an illustrative round number, not a statement about the current world population.
- The discrete-generation structure deliberately ignores overlapping cohorts. A cohort-component projection is required for realistic short- and medium-term forecasting.
- The replacement benchmark $F \approx 2$ is simplified. In real populations, replacement-level TFR is not exactly 2 and varies with mortality and sex ratios.
- Threshold calculations use continuous logarithmic solutions and are therefore fractional generations. Integer-generation simulations would cross the threshold at the next whole generation.
- All added calculations in this expanded edition are mathematical consequences or refinements of the original scenario model, not empirical predictions.
- “Voluntary extinction” and “multicivilizational suicide” are philosophical and rhetorical descriptions of trajectories under specified conditions; they are not technical demographic categories.

- The term “civilization” is used here in a historical-philosophical sense, not as a statistical unit. Country- or region-level data are used only as imperfect approximations to broader civilizational processes.

## Demographic references for comparison

United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects 2024; World Bank, World Development Indicators, “Fertility rate, total (births per woman)”, 2024 data; OECD, Society at a Glance 2024 and OECD Employment Outlook 2025, sections on fertility and demographic change.